2006 MARINE SURVIVAL FORECAST OF SOUTHERN BRITISH COLUMBIA COHO

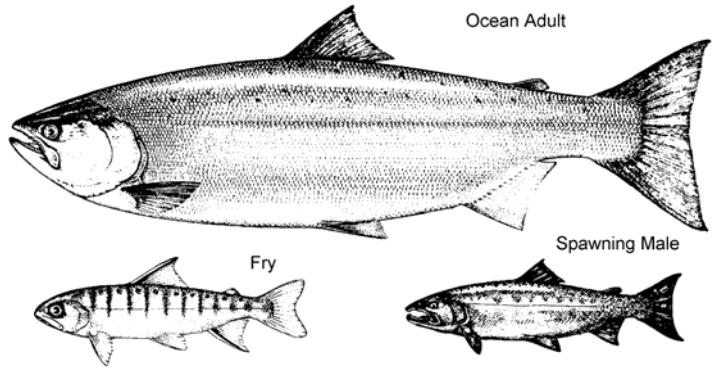

Figure 1: Coho salmon at three life stages: freshwater rearing fry; ocean rearing adult; and returning male in spawning colours. This image has been used on previous coho Stock Status reports, origin unknown.

Figure 2: The Province of British Columbia, showing the major rivers in the South Coast, Lower Fraser and Interior BC areas.

Context

A forecast for southern British Columbia coho returning in 2006 was requested by DFO Fisheries and Aquaculture Management to aid decisions regarding coho stocks. Stock assessment and forecast documents on southern BC coho have been submitted to the Pacific Scientific Advice Review Committee (PSARC) since 1995. Simpson et al. (2004) provided the most recent full assessment of the forecast methods and should be referred to for more detailed information. The 2005 and 2006 forecasts were requested as SAR documents that do not include the detailed description of the data sources, their assumptions and uncertainties, and the models. This forecast report relies on identical methods reviewed by PSARC on this subject.

An assessment framework for coho salmon is not yet available and is in preparation.

SUMMARY

- 2005 marine survival and abundance observations were generally lower than forecast, and in some cases much lower than forecast. Since the 1993 return, marine survivals have been between 1% and 6% and the 2005 values were at the low end of this range.
- Forecast models predict extremely low marine survivals and abundances for 2006, similar to 2005. Interior Fraser, Georgia Basin East and Georgia Basin West are stocks of concern.
- The preliminary distributional forecast is for a stronger outside distribution than 2005.
- Monitoring programs for coded-wire tagged adipose fin clipped coho must be maintained or strengthened to continue to monitor fishing-induced impacts.

INTRODUCTION

During the 1990s DFO Fisheries Management and Stock Assessment observed an unprecedented decline in the marine survival of southern BC coho populations. Hatchery indicator stocks decreased from a mean survival of 6.6% (Brood Year (BY) 1983-1992) to 2.5% (BY 1993-2001) and wild indicator stocks from 10.2% to 4.4% during the same time period. In response, all directed coho fisheries were curtailed to protect weaker stocks such as Thompson River and Strait of Georgia coho. This management action resulted in a decrease of the total exploitation rate (all sectors) from a mean of 67% (BY 1983-1994) down to 17% (adipose fin clip (AFC) coho, BY 1995-2001) and 4% (non-AFC coho).

These measures allowed more coho salmon to return to natal creeks. Bradford et al. (2000) found that a minimum rate of 2.9% marine survival is required for the population to sustain itself.

The scope for this forecast is Southern BC, which consists of several Management Units:

Johnstone Strait/Mainland Inlets (JST): Johnstone Str., Queen Charlotte Str., and adjacent inlets (Areas 11, 12 and the northern portion of Area 13)

North-west Vancouver Island (NWVI): Estevan Pt. to Cape Scott (Areas 25-27)

South-west Vancouver Island (SWVI): Victoria to Estevan Pt. (the remaining part of Area 19 and Areas 20-24)

Georgia Basin – East (GBE): east side of the Str. of Georgia, excluding the Fraser R. system (Areas 15, 16, 28 and the coastal foreshore streams in Area 29)

Georgia Basin – West (GBW): west side of the Str. of Georgia (Areas 13 (southern portion), 14, 18 and the Str. of Georgia portion of Area 19

Lower Fraser (LowFr): Lower Fraser R. system as far upstream as Hell's Gate (Area 29)

Interior Fraser (IntFr): upstream from Hell's Gate, including the Thompson R. system (Area 29)

ASSESSMENT

The process of developing the southern BC coho forecast is as follows:

1. Gather mortality data on coded-wire tagged/adipose fin clipped (CWT/AFC) coho from marine and freshwater fisheries and indicator escapement information from the previous forecast year as well as salinities from February and March of the current year.
2. Add the data to the forecast models.
3. Examine the predictive power of each model and select the best one to use for the next forecast year.

Changes from previous reports

Salmon River (LowFr) is no longer used as a wild coho indicator and was removed from this analysis.

Goldstream Hatchery (GBW) has been releasing coded-wire tagged coho smolts since 1998 (brood year 1996) and has been added as a Strait of Georgia hatchery indicator. The marine survival trends have been analyzed using the same time series models as other indicators. The

CWT/AFC release is not included with the Strait of Georgia hatchery index because this stock does not migrate through the areas surveyed by this program.

Stock trends

Since the 1993 return year, marine survivals ranged between 1% and 6%. The 2005 return marine survival was at the bottom of this range (brood year 2002). With the exception of Robertson Creek Hatchery and Area 13 aggregates, the 2005 survivals were all less than the forecast by the time series models, and most were less than the lower 50% confidence limit.

	2005				Change
	Forecast	50% CI	Model	Observed	from forecast
Johnstone Strait [1]					
Area 12	1,458	993 - 2140	3YRA	1,170	-20%
Area 13	168	113 - 249	3YRA	239	42%
Georgia Basin West					
Big Qualicum	0.012	0.008 - 0.019	LLY	0.001	-92%
Quinsam	0.012	0.009 - 0.016	3YRA	0.005	-58%
Goldstream	N/A			0.004	
Black (wild)	0.040	0.029 - 0.056	3YRA	0.014	-65%
Lower Fraser					
Inch	0.025	0.013 - 0.044	LLY	0.015	-40%
Salmon (wild)	0.043	0.031 - 0.058	LLY	N/A	
Str. Of Geo. Hatcheries [2]	0.011	0.010 - 0.012	CPUE	0.006	-45%
Interior					
Thompson aggregate	30,688	19,527 - 48,230	3YRA	11,261	-63%
Southwest Vancouver Island					
Robertson	0.033	0.020 - 0.053	Sibling	0.045	36%
Carnation (wild) [3]	214	156 - 272	Euphausiid	138	-36%
Distribution Index (P_{inside})	0.270	0.197 - 0.357	Salinity		

[1] Average return (catch plus escapement) per monitored stream.

[2] Total return of Inch, Big Qualicum and Quinsam hatcheries of CWT/AFC adults divided by the total release of CWT/AFC coho from those hatcheries.

[3] Return of all adults to Carnation Creek (tagged and untagged)

Table 1. Forecasted 2005 coho marine survival and abundance values with 50% confidence intervals and values observed in 2005.

Forecast models

1. Time Series Models.

The following four models were applied in all abundance and survival forecasts:

- '**Like last year' (LLY):** the forecasted survival or abundance will remain the same as that observed in the previous year;
- **Three year average (3YRA):** the forecasted survival or abundance will equal the mean of the previous three years of observed values;

- **One year trend (RAT1):** the change in survival or abundance from last years observed to this years forecast will equal the previous change (from that observed two years ago to that observed last year); and,
- **Average three year trend (RAT3):** the change in survival or abundance from last years observed value to this years forecast will equal the mean of the previous three changes.

2. Sibling Model.

This forecasts the adult return to an indicator using a regression that relates past adult returns to the escapement of jacks one year prior. Forecast returns to hatcheries are converted to forecasts of survival by dividing returns by the smolt releases.

3. Euphausiid Model.

This model forecasts the return to Carnation Creek using a regression that relates past adult returns to the abundance of a euphausiid species in Barkley Sound one year prior. This species is an important prey for coho in Barkley Sound.

4. CPUE Model.

This is a forecast of the total return of CWT/AFC coho for the three hatchery indicators in the Georgia Basin: Quinsam, Big Qualicum and Inch. The catch of hatchery-marked coho in July of their first year in the Strait (age-2) is related in a regression to the CWT/AFC return to these hatcheries the following year (age-3). The catches are from a standard trawl survey conducted annually. The return forecast is then divided by the total CWT/AFC release from the hatcheries to provide a marine survival forecast.

5. Stock-Recruit Model.

The time series of standardized escapements and returns to Area 12 and Area 13 streams were used as inputs to Ricker stock-recruitment analyses, which were then used to forecast recruitment and returns using observed spawner indices in the brood year.

6. Distribution Forecast.

Young coho originating in the Georgia Basin are thought to rear in the Strait of Georgia until the fall, when they primarily migrate to the west coast of Vancouver Island. A varying proportion return to the Strait soon after, in late winter, and are available to 'inside' fisheries in their last year at sea. This proportion has been related to salinity in the Strait in this late winter period: low salinities are associated with few coho returning early. The salinity model predicts the proportion of catch taken in the Strait if pre-1997 fishing regimes were in place and this proportion, P_{inside}, is now used as an index of inside distribution. P_{inside} should not be interpreted as the proportion that is occupying the strait in their last year.

A retrospective analysis is done for each time series model to choose the one with the best fit to the observed data. If other models were also used, e.g. a sibling model, a retrospective analysis was done for them and compared to the best time series model (using common time periods). The model that best fits the past data was used to forecast the following year return either as marine survival or adult return.

Sources of uncertainty

Commercial by-catch of coho

Exploitation rates were estimated by using the by-catch of coho in non-targeted commercial fisheries from a base period of return years 1987 – 1997 and compared to the effort in 2005.

This method may no longer be available for the 2006 fisheries as the nature of the fisheries has changed and the base period is no longer applicable.

Sport catch, especially Quinsam FW

CWT-based estimates of sport fishing mortality have become less certain due to changes in creel survey study designs, and calculations of CWT recoveries.

Freshwater creel surveys were limited to Big Qualicum River, Nicomen Slough (Inch Creek Hatchery) and the Fraser River. In 2005 large fishing effort was reported for Quinsam River; however without a creel survey the CWT/AFC catch associated with this release could not be estimated and was not included. The observed escapement of AFC-CWT coho to Quinsam hatchery was 194, with 11 more estimated to be caught in known fisheries so a large fishing effort on the Quinsam could have a significant effect on the marine survival and exploitation rates.

Predictive power of the time series models

Time series models assume continuing trends based on past patterns in the data and have little or no predictive power when trends change.

Results of forecast

	2005	2006			Change (2006 forecast minus
	Observed	Forecast	50% CI	Model	2005 observed)
Johnstone Strait/Mainland Inlets [1]					
Area 12	1,170	1446	952 - 2196	3YRA	24%
Area 13	239	261	170 - 400	3YRA	9%
Georgia Basin - West					
Big Qualicum	0.001	0.001	0.001 - 0.002	LLY	0%
Quinsam	0.005	0.007	0.005 - 0.010	3YRA	40%
Goldstream	0.004	0.012	0.006 - 0.023	3YRA	208%
Black (wild)	0.014	0.026	0.018 - 0.038	3YRA	86%
Lower Fraser					
Inch	0.015	0.015	0.009 - 0.026	LLY	0%
Salmon (wild)	N/A				
Str. Of Geo. Hatcheries [2]	0.006	0.007	0.005 - 0.009	CPUE	17%
Interior Fraser					
Thompson aggregate	11,261	18,341	11,759 - 28,608	3YRA	63%
South-west Vancouver Island					
Robertson	0.045	0.045	0.021 - 0.095	LLY	0%
Carnation (wild) [3]	138	31	17 - 59	Euphausiid	-78%
Distribution Index (P_{inside})		0.195	0.138 - 0.268	Salinity	

[1] Average return (catch plus escapement) per monitored stream.

[2] Total return of Inch, Big Qualicum and Quinsam hatcheries of CWT/AFC adults divided by the total release of CWT/AFC coho from those hatcheries.

[3] Return of all adults to Carnation Creek (tagged and untagged)

Table 2. Observed 2005 coho marine survival and abundance values and 2006 forecasts with 50% confidence intervals.

Johnson Strait/Mainland Inlets

In 2005 the observed return in Area 12 was 20% less than forecast while the Area 13 return was 42% above forecast (Table 1). The Area 12 return was slightly less than the brood and over

half the 2004 return. The Area 13 return was a substantial improvement over the brood year (2002) and similar to the previous year's return. Smolt production was low for 2004, which was at least partly affected by the extremely dry spring (low stream flow). More average smolt production occurred in 2005 for the subsequent return in 2006.

The 2006 forecasts are 24% (Area 12) and 9% (Area 13) greater than the 2005 return. Abundance remains poor and below average in Area 12 and well below average in Area 13 (see Simpson et al. (2004) for definitions). The forecast continues the low abundance trend.

North-west and South-west Vancouver Island

The 2005 Robertson coho survival was higher than forecast and the 2005 Carnation return was much lower than forecast and lower than the lower 50% CI bound. The Carnation return was 40% of the brood and the return was 55% of the geometric mean (1972 – 2002).

The euphausiid model predicts a very low return (31 coho) to Carnation Creek from 2,974 smolts, indicating a 1.0% marine survival. The Robertson Hatchery forecast is for a marine survival of 4.5%.

Georgia Basin - West and Georgia Basin - East

The 2005 marine survivals for both hatchery and wild indicators were lower than the forecasts and the lower 50% CI bound. In particular, Big Qualicum was extremely low at 0.1%. The wild indicator, Black Creek, continues to have better marine survivals than the hatchery stocks.

The 2006 forecast is for continuation of low marine survivals of 0.1% to 1.2% for hatchery coho and 2.6% for wild coho. The CPUE forecast for aggregate Strait of Georgia hatchery stocks is 0.7%.

Lower Fraser

The 2005 marine survival for Inch Creek hatchery was less than the forecast, but was within the 50% CI, similar to results for GBW indicators and the SWVI wild indicator (Table 1).

The marine survival forecast is 1.5%, which will continue the trend of very low survivals over the last 10 years.

Interior Fraser

The total abundance of Thompson River coho was 11,300, which was far below the forecast (31,000 coho). The abundance in 2005 was far less then the abundance observed in 2004 (34,500), and just 21% of the brood year abundance of 53,100. The estimated spawning escapement of coho in the Thompson River drainage in 2005 was 9,200. The total abundance and spawning escapement observed for the entire Interior Fraser River Management Unit was approximately 16,700 and 14,000 coho salmon, respectively.

The 2006 forecast for Thompson River coho is 18,300, which is approximately 27% of the geometric mean abundance of the time series, but represents a slight increase over the brood abundance of 15,900 fish.

It should be noted that the last three years of Thompson River coho abundances have failed to meet the abundances of their corresponding brood years. Additionally, the forecasted abundance is close to the lower threshold escapements suggested in the proposed IFR Coho Recovery Strategy to ensure genetic and demographic needs are maintained in the entire Management Unit

Distribution

The final P_{inside} statistic for 2005 was 0.270. The 2006 P_{inside} statistic is 0.195 indicating an even stronger 'outside' distribution than in recent years.

CONCLUSIONS

The 2005 returns (with the exception of Robertson Creek Hatchery and Area 13 aggregate) were considerably lower than forecasted and most were below the 50% confidence intervals. It should be noted that 4 of the 5 lowest indicators (Big Qualicum, Black, Thompson, and Inch) are stocks that migrate through the Strait of Georgia. The distribution forecast of a stronger outside year would place these stocks in outside waters for a longer period of time.

In light of the abundance trend, coupled with the further decline of marine survival rates of southern B.C. coho stocks observed in 2005, the forecast of marine survival and abundance should be characterized as extremely low and caution should be exercised when planning fisheries or activities which may exploit these stocks.

Monitoring of CWT/AFC coho catch in all sources of mortality should be improved and respond to shifting fishing pressures. In particular, commercial catch must be monitored as previous estimation models are no longer reliable.

SOURCES OF INFORMATION

The data, models and treatments that were used in this report are fully documented in Simpson et al. (2004). Please refer to that document for descriptions and background information.

The coho forecast for southern British Columbia requires data from many sources and is very much a collaborative document. Data analysis of Thompson River and Johnstone Strait coho was completed by Michael Chamberlain and Pieter Van Will, respectively. Dr. Ron Tanasichuk provided euphausiid data and analysis. The CPUE data was collected and analyzed by Dr. Ruston Sweeting. Diana Dobson provided the commercial by-catch exploitation rate estimates of coho. Creel survey data was provided by Joe Tadey (Lower Fraser), James Patterson (West Coast Vancouver Island) and Shawn Stenhouse (Strait of Georgia). Roberta Cook provided escapement data from the hatcheries. Wild coho data was provided by Dave Nagtegaal (Black Creek) and Dr. Peter Tschaplinski (BC Ministry of Forests - Carnation Creek).

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